Clean Competition: How Competitive Elections Clean-up the Air in Mexican Municipalities.

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Abstract: This paper evaluates whether and how electoral competition across Mexico’s municipalities influences local air quality. Past research suggests that greater electoral competition makes politicians more accountable to voters and stimulates a shift towards the provision of public goods. Most recent studies use social spending or infrastructure to measure public goods. However, the ability to target social programs and infrastructure projects to specific constituencies can reduce their “public” nature. Instead, we study the relationship between electoral competition and air pollution. The disperse nature of clean air and the trade-off faced by local politicians between providing clean-air and promoting the local economy makes the provision of clean air a more difficult public good. Using satellite data to capture air quality across Mexico’s municipalities, our main finding is that electoral competition measured by the effective number of parties is associated with lower level of PM 2.5 air pollution.
Introduction

Electoral competition and government responsiveness is hardly a new topic for students of politics. There is often thought to be a positive link between electoral competition and the provision of public goods. The basic argument rests on theories of electoral accountability, which posit that elections offer citizens the opportunity to influence policy outcomes by removing representatives that perform poorly (Austen-Smith and Banks 1989; Ferejohn 1986). Most studies use the level of social spending and infrastructure projects as measures of public goods. However, the ability to target social programs and infrastructure projects to specific constituencies can reduce their “public” nature. Environmental public goods, such as air quality, on the other hand, are some of the purest types of public goods. They are both non-excludable and non-rival. Moreover, the disperse nature of clean air as well as the trade-off, often faced by politicians, between providing environmental public goods and protecting the vibrancy of the local economy makes the provision of clean air a more difficult public good to target and to politicize for electoral benefit. Our first contribution, therefore, is to assess the relationship between electoral competition and the provision of a less studied, pure(r) public good.

This paper makes a second important contribution by studying a public good that has significant distributive implications that stem from regulatory enforcement rather than fiscal outlays that provide jobs, services, or cash transfers. Regulating pollution can negatively affect businesses, especially small enterprises and those in the informal sector, resulting in increased poverty (Dasputa et al 1998). Small and informal producers tend to emit far more particulate emissions than their larger counterpart, making them targets for anti-pollution policies. However, small and informal enterprises also tend to have far more difficulty reducing contamination even when the need capital investments are small. For example, in the 1990s, a typical brick kiln in
Ciudad Juárez, Mexico used tires and other debris as fuel, making kilns one of the most important sources of air pollution. On average, kilns employed six people and had weekly profits of only $100 (Backman and Barrister 1998). Low profits and a lack of credit make it almost impossible for operators to adjust production methods. As such, programs in Ciudad Juárez and numerous other municipalities to regulate and reduce emissions from kilns jeopardized the livelihood of thousands of already impoverished individuals.

The clear distributional consequences for small and informal businesses makes properly regulating pollution politically difficult, especially in Latin America. This is partly because individuals in the informal sector participate more in politics than their formal counterparts (Thornton 2000) and strongly link their evaluations of politicians to their economic circumstances (Singer 2016). Individuals in the informal sector are also likely to belong to trade or other local associations that allow them to lobby against pollution control efforts. Regulating the informal sector may also threaten existing clientelistic relationships. Tendler (2002) finds that local Brazilian politicians often enter into an unspoken deal with small enterprises, keeping police and inspectors from harassing them in exchange for political support.

This paper makes a third significant and empirical contribution to environmental studies in international and comparative politics by using satellite air pollution data to study the relationship between electoral competition and air pollution at the municipal level within Mexico. Large-N studies of environmental politics often adopt a country-level approach. This is understandable because theories often focus on the environmental effects of national-level political institutions (Fredriksson and Millimet 2004; Scruggs 2003), and because most cross-national data on pollution is only available at the national level. Data on air pollution at the
monitoring station level are available;\(^1\) however, most monitoring stations are in the OECD countries.\(^2\) Fine-grained data on sub-national level environmental outcomes, especially for developing countries, are difficult to find and limits our ability to study within country variation in environmental outcomes. Studying subnational level variation is important for students of environmental politics, because ultimately pollution is a function of local characteristics such as climate conditions, geography, and economic and social conditions. The use of satellite data, such as those provided in grid-cells as small as 0.1 × 0.1 decimal degree cell resolutions (about 11 km by 11 km at the Equator) allows us to model and test within country variation in air pollution.

The relationship between electoral competition and the provision of public goods is likely to be a complex one. We argue that there might be mediating factors that influence the provision of environmental public goods. For instance, it is likely that electoral competition can only lead to the greater provision of public goods if the public prioritizes it. If voters prioritize economic growth, competitive elections may increase government investments in areas such as infrastructure (e.g., building roads and bridges) which is sometimes associated with more pollution. At the same time, encumbers in poorer municipalities may find it more politically efficient to provide private goods to ensure electoral victory. Therefore, we also examine whether electoral competition has a stronger effect on the provision of clean air in wealthier municipalities.

\(^1\) For example, see Bernauer and Koubi (2009).

\(^2\) Even within some of the richest countries, there are not enough stations to cover the ground.
Mexico is a useful and interesting case for a few reasons. First, it presents a particularly difficult test because it is a newly democratic regime (after the single-party rule of the PRI) and a country still eager to develop its economy. As such, a culture of electoral accountability is not as fully developed among voters as in more established democracies and we should expect voters’ preferences to be more geared towards economic growth. Additionally, there is significant variation in the level of electoral competition at the municipal level, which provides us with significant leverage to uncover the role of local politics in providing environmental public goods.

The connection between pollution and electoral competition may seem tenuous, especially in a developing country and at the local level. However, there is good reason to believe that municipal governments play an active role in and care about air pollution in Mexico. The Mexican constitution grants municipalities the ability to develop ecological policies, the power to deal with low-level ecological emergencies and risks, the responsibility of regulating and preventing air and water pollution, managing the disposal of solid waste, and evaluating and regulating the environmental impacts of urban growth (Assetto, Hajba and Mumme 2003). They are also responsible for zoning and have the power to create ecological zones (Grindle 2007). The environmental law passed in 1988 decentralized significant authority over environmental policy to the municipal level. It charges municipalities with monitoring and ensuring the application of federal environmental regulations; it entrusts municipalities with the responsibility
to address all environmental problems within their jurisdiction not already specifically reserved for federal or state authorities.³

Additionally, while Mexico is a country that is eager to develop economically it is also a country in which people care about air pollution. Survey data from the World and European Value Surveys (WEVS) reveal the saliency of environmental preferences in the Mexican public. In 1996 and 2000, Mexican respondents indicated a preference for protecting the environment with a ratio close to 3:2; in 2005, the ratio of Mexicans choosing the environment to those choosing economic development almost reached 2:1: these were well above the response ratio of citizens in similar Latin American countries.⁴ Rodríguez-Sánchez (2014) more recently shows

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³ While the specific policy responsibilities of municipalities vary by state, most have the ability to pass environmental regulatory ordinances and sanction violations of those ordinances (Assetto, Hajba and Mumme 2003).

⁴ The WEVS provides a question on citizens’ relative preference regarding “protecting environment vs. economic growth.” It asks respondents to choose from two statements: “Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs” vs. “Economic growth and creating jobs should be the top priority, even if the environment suffers to some extent.” We consider respondents choosing the first statement as having environmental preferences.
that Mexicans are willing to pay to reduce air pollution: on average, a household head would pay $46.90 to $283.61 for a one-unit reduction in particulate matter emissions per year.\(^5\)

To explain air quality across time and across Mexico’s municipalities, we use the *Effective Number of Parties* and the *Margin of Victory* in city council (ayuntamiento) elections to measure electoral competitiveness. We test both its marginal effect on air pollution and its interactive effect with local environmental demands (using GDP per-capita as a proxy). We find that party dominance on city councils (a lower *Effective Number of Parties*) is associated with poorer air quality, while a lower *Margin of Victory* by the leading party has no clear relationship with cleaner air. We find no evidence for the interactive effect between GDP per-capita and either measure of electoral competition. The rest of the paper is organized as follows: First, we discuss theoretical connections between electoral competition and public goods provisions. Second, we provide a brief discussion of actions municipal government can and have taken to impact air pollution in Mexico. We then present the data and the empirical findings. Finally, we conclude and discuss directions of future research.

**Electoral Competition and Public Goods Provisions**

We aim to explain subnational variation in air pollution. While there are numerous potential factors that can explain air quality including climate, geographic conditions, and the nature of the local economy, we focus on political explanations. We treat air quality as a public good and rely

\(^5\) In constant 2000 dollars. In Rodríguez-Sánchez (2014), the mean of the PM emissions per area variable is about 0.80 and the standard deviation is 0.95. This suggests that one-unit reduction in PM is close to one standard deviation reduction.
on theories regarding public goods provisions to explain variation in air quality across Mexican municipalities. Such theories often implicitly assume pure public goods that are fully non-rival and non-excludable. Yet, in reality, most studies focus on public goods or services that suffer from some degree of rivalry and some crowding effects (e.g., infrastructure, education, health care, and social welfare). The enjoyment of a unit of an impure public good goes down with the number of people consuming it. Air quality, on the other hand, is one of the purest public goods. Clean air is less subject to crowding effects or rivalry. Non-excludability is also less of a concern for air quality. Moreover, almost all social spending and infrastructure projects can be targeted to specific groups making them essentially club goods. While the location of high polluting activities may be strategically placed (Monogan, Konisky, and Woods 2015), air quality at the municipal level is much more difficult to direct towards a specific constituency.

There are a number of theories linking political factors to the provision of public goods. Some, such as the selectorate theory,⁶ are not directly relevant to subnational regimes that have similar institutions. Rather than review all of these theories, we focus on an approach related to electoral competition and government responsiveness. This approach often predicts a positive link between electoral competitiveness and the provision of public goods. The basic argument originates from the electoral democratic theory, which posits that competitive elections offer citizens the opportunity to influence government representatives by threatening to remove the

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⁶ Selectorate theory posits that as the size of the winning coalition increases, a ruler will rely more on the provision of public goods because the relative price of doing so falls compared to buying support with private good transfers (Bueno de Mesquita et al. 2003). The theory predicts that regimes with large winning coalitions (often democracies) typically provide more public goods.
incumbent for poor performance and by selecting representatives who are competent and share the public’s preferences (Austen-Smith & Banks 1989; Ferejohn 1986).

**Higher Electoral Competition, More Public Goods?** It is generally thought that democracies, which are presumed to be more competitive, tend to provide more public goods than other forms of government. Competitive elections force politicians to address constituent demands. Ambitious politicians hoping to maintain their office and advance their political careers face a constant threat of removal. Political survival requires that they perform well. For instance, Fox (1994) argues that competition breaks down clientelist bonds, leading to more social spending as candidates and officials come under greater scrutiny. Wittman (1989) shows that political competition pushes governments toward efficient outcomes by lowering the opportunism of politicians. Becker (1983) finds that even in the presence of successful pressure groups, competition should cause governments to correct market failures (reflected in lower pollution), since policies that raise efficiency should win out because they produce gains rather than deadweight costs to society. Brown and Hunter (1999) show that democracies tend to spend more in general, and specifically on education.7

However, the aforementioned theoretical predictions following this electoral democratic thesis have received mixed empirical support, particularly when studying developing countries.

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7 Treating education, especially primary education, as a public good, many studies suggest that democracy increases government education spending and improves educational outcomes (Ansell 2008; Nooruddin and Simmons 2009; Stasavage 2005; Hecock 2006; Huber, Mustillo and Stephens 2008).
In the Mexican context, studies conducted at the state level often find a positive connection between electoral competition and public goods (or government performance). For instance, Hecock (2006) finds that higher electoral competition is associated with more education spending. Studies conducted at the municipal level, on the other hand, often reveal null results. For instance, Cleary (2007) finds no connection between electoral competition and public goods (sewer and water coverage). Grindle (2007) finds no clear relationship between competition and government performance, with the latter measured as an index measuring efficiency, effectiveness, responsiveness, change initiatives, and development orientation. Moreno-Jaimés (2007) is also unable to find a discernable relationship between electoral competition (measured by margin of victory) and basic service provision (water drainage) in Mexico. Euler (2014) shows that competition (margin of victory) has no positive relationship with the provision of public services. The only exception that we know of is Hiskey (2003), which shows that municipalities that lack political competition and were dominated by the PRI are associated with lower public service provisions.

Similarly, studies based on non-Mexican cases show mixed empirical results at the subnational level. Arvate (2013) shows that electoral competition increases student enrollment, teachers, and free immunizations in Brazil. Pereira and Melo (2009), on the other hand, find that the influence of competition on social spending depends on the degree of checks and balances within Brazilian states, while Cavalcante (2013) finds no effect for electoral competition. Chhibber and Nooruddin (2004) show that in India, greater competition is not necessarily beneficial because states with more than three effective parties provide fewer public goods. Elsewhere, Sánchez Torres and Pachón (2013) find political competition increases public goods at the municipal level in Columbia; Galasso and Nannicili (2011) and Paola and Scoppa (2010)
find that political competition results in the election of better prepared officials in Italy, who are thought to be more likely to implement programmatic policies. Finally, Ashworth, et al (2014) associate electoral competition with positive municipal policy outcomes in Flanders.

*Local Environmental Demand as a Conditional Factor?* The inconsistent empirical support, especially in developing countries, may stem from a lack of information by voters, a tendency to vote along ethnic lines in ethnic diverse societies, the absence of credible political challengers, corruption and low state capacity, lack of long-term government credibility, and pre-existing clientelist ties (Boulding and Brown 2014). For instance, Kitschelt and Wilkinson (2007) argue that the electoral competition increases public goods provision only if there exists a high level of development and a lack of clear ethno-nationalist groups that leaders may exploit to win

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8 Electoral competition may also lead to less public goods provisions. For example, in newly democratic regimes, political officials may use private goods to target particular groups to secure votes. This is particularly the case as elections become more competitive (Cleary 2007; Magaloni et al. 2007). Additionally, the political impetus to provide clean air may be limited by the complexity of the issue. For complex public goods where different levels of government hold different regulatory responsibilities, voters could have a hard time isolating the role of specific governments in determining their outcome, even when the policy outcome itself is easily observable. Air quality within a municipality depends upon numerous factors other than the competence of the municipal government alone. Voters might find it hard to assess government competence based on the observed outcome. As a result, one might expect that “complex” public goods will not be prioritized by politicians who seek to garner political support.
elections. If this contingent development is not met, clientelist ties may not be broken and political elites may provide public services which are in fact clientalist in nature. This is because richer voters are less susceptible to vote buying making the strategy significantly less efficient (Brusco, Nazareno, Stokes 2004; Dixit and Longregren 1996; Magaloni et al. 2007). The wealth of voters may also increase the indirect costs of securing votes through clientelistic networks by providing a negative signal to middle-class voters about the quality of government. This creates an electoral trade-off for politicians between securing votes from the poor and losing votes from the non-poor (Weitz-Shapiro 2014).

Even if electoral competition increases government responsiveness, voters might not always prioritize the environment. If voters choose economic growth over the environment, competitive elections may actually result in the provision of public goods or the implementation of policies that lead to poor environmental outcomes. For example, governments may invest in areas such as infrastructure that may actually be harmful to environmental protection. This implies that we need to consider the interactive effect between electoral competition and voters’ preferences. Since environmental values are often believed to increase with wealth, we take into account the socio-economic composition of voters and popular demand for environmental public goods.

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9 Boulding and Brown (2014) include a test for this and find that the level of resources given to members of the president’s party in Brazil is greater than that given to those that are not members. Likewise, Cleary (2007) argues that vote buying can occur without an improvement in public goods.
goods using local per capita GDP.\textsuperscript{10} Although we would have preferred to use a more direct measure of the number of voters living in poverty, Mexico does not collect this data at the municipal level.\textsuperscript{11}

**What can Mexican municipalities do about Air pollution?**

The Mexican federal system consists of three independent and constitutionally recognized tiers of government that work independently and conjointly to make and administer policy. While the system is relatively centralized, all three levels of government have responsibilities related to the protection of the environment. Municipal governments specifically play an important role both independently and in partnership with state and national governments, and the constitution of Mexico gives municipalities a series of responsibilities related to environmental management,

\textsuperscript{10} The Environmental Kuznets’ curve posits that the environment is a relatively low priority for citizens in the early stages of development, but it becomes a higher priority as they become better off (Grossman and Krueger 1995). The evidence suggests that this argument does not hold for all pollutants, for all types of political systems, or for all regions (Cole and Neumayer 2005). Because of lack of within-country comparable data on demand, income is the best available proxy.

\textsuperscript{11} Magalon, et al (2007) construct an index of relative poverty based on a factorial analysis of serval indicators often associated with poverty. However, many of these are actually measures of public services delivered by municipal governments. If political competition influences the delivery of public services, the said index would not be independent of our primary independent variable.
most of which were discussed in the introduction. There are over 2,400 municipalities in Mexico, which vary greatly in size and population, and each has its own elected government. Recently efforts to decentralize environmental regulation and policymaking has brought municipal governments to a higher degree of political prominence.\textsuperscript{12} Municipal governments can have an active and decisive role in combating air pollution by working both alone and in tandem with other municipal governments or state governments to control and monitor the sources of air pollution.

Municipal governments can influence air pollution levels in many different ways. The day-to-day routine tasks associated with administering local government can have a huge impact on air pollution levels in a municipality. These tasks include; permitting, monitoring emissions, zoning, maintaining parks and green spaces, urban planning, and the implementation of a public transportation system. These activities can have a positive or negative effect on air pollution regardless of the express purpose of these activities. For example, transportation has consistently been considered a major cause of elevated air pollution particularly in urban areas (Krzyzanowski, Kuna-Dibbert, Scheider 2005). An efficient public transportation system can help reduce the number of drivers on the road which can reduce the amount of vehicular emissions. This occurs even if the express purpose of this public transportation system was to alleviate traffic. Even decisions about how a municipality will handle solid waste can have huge effects on air pollution. In many municipalities, this choice is primarily based on space, cost, and infrastructure (Buenrostro and Bocco 2003). However, the choice to burn solid waste, a cost

\textsuperscript{12} Municipalities are recognized by Article 115 of the Mexican constitution as “the basis of their [States] territorial division and political and administrative organization.”
effective method for many municipalities, has adverse effects on air quality (Wiedinmyer, Yokelson and Gullett 2014). While a municipal government can take air pollution into consideration when performing their daily tasks and responsibilities, they are likely to affect pollution levels even when those levels were never expressly considered.

Municipal governments can also play an active hand in trying to minimize air pollution in their jurisdictions. This is particularly the case when it comes to the monitoring and regulation of vehicle emissions, a major source of air pollution. Many municipalities have taken it upon themselves to monitor and minimize the effects of pollution from vehicular emissions. For example, the municipal government of Ecatepec in the state of México began to assess both the presence and make-up of local air pollution and to invest in environmental monitoring stations (Fernandez Román 2009). The mayor of Mexicalí, in December of 2016 began a process of expanding monitoring stations to ensure that air quality in the entire municipality can be monitored (Molina 2016) The mayor of Mexicalí, in December of 2016 began a process of expanding monitoring stations to ensure that air quality in the entire municipality can be monitored (Molina 2016). In Ciudad Juarez, air pollution in the late 1990’s led municipal governments to begin a vehicle emissions testing program with an aim to remove inefficient vehicles from the streets (National Institute of Ecology 1998). Ciudad Juarez and other municipalities also worked to reduce emission from brick kilns (Backmann and Barrister 1998). Municipal governments have also begun a process of infrastructure development that is following plans designed to alleviate traffic and improve public transportation. Finally, the city has begun to regulate the operation of businesses and building practices to ensure that new homes are built with more efficient insulation to help minimize emissions from heating and cooling (National Institute of Ecology 1998).
While municipal governments in Mexico do not necessarily have primary responsibility for the regulation of air pollution in Mexico, they are important partners for state and federal governments, and can have a powerful direct and indirect effect on pollution levels.

**Data**

*Local PM2.5 Concentrations:* Our dependent variable, PM2.5, is the municipal annual average concentration levels of particulate matter of 2.5 micrometers or smaller, measured in micrograms per cubic meter. We use satellite-derived PM2.5 data (Boys et al. 2014; van Donkelaar et al. in press). The data are provided in grid-cells with 0.1 × 0.1 decimal degree resolution, which is about 11km by 11km at the Equator. We re-sampled the grid data in ArcMap so that each grid is evenly divided into 100 smaller grids: each of them is of the size of roughly 1.1km by 1.1 km after resampling. We then overlaid the resampled PM2.5 grids over the municipal polygons representing Mexico’s municipalities, taking the average PM2.5 concentration levels of all grids falling within a municipal polygon. The resulting average PM2.5 level at the municipal level is our dependent variable.

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13 These are estimated ground-level fine particulate matter (PM2.5) by combining Aerosol Optical Depth (AOD) retrievals from the NASA MODIS and MISR instruments with aerosol vertical profile and scattering properties simulated by the GEOS-Chem chemical transport model.
Figure 1: PM2.5 Levels in Mexican Municipals (using 2010 municipal boundaries), 1999, 2004, 2009, and 2014.
PM2.5 concentrations is a particularly important measure of air pollution. Exposure to fine particles is associated with premature death as well as increased morbidity from respiratory and cardiovascular disease, especially in the elderly, young children, and those already suffering from these illnesses. A recent study suggests that long-term exposure to particulate matter has contributed to an enormous loss of life expectancy in China, as much as over five years (Chen et al. 2013).\textsuperscript{14} Figure 1 shows the municipal annual average PM2.5 concentration levels in Mexico for 1999, 2004, 2009, and 2014. It seems that over the years, Mexico has managed to lower the level of PM2.5 pollutions.

However, we still see significant within-country variation. Moreover, in 1999 air pollution affected a large swath of the eastern and west central parts of the country, concentrating around large urban areas. Some of the most polluted municipalities include those surrounding the capital Mexico City, Ciudad Juárez, the largest city in north central Mexico near the US border, and municipalities surrounding Saltillo in the northeast. By 2014, however, this distribution of air pollution has shifted significantly. Levels of air pollution in the northeast have decreased, while pollution has become more concentrated in southern and south central parts of the country, particularly in the municipalities surrounding Mexico City. Many of these states and municipalities in the southern parts of the country are also places where subnational elections tend to be less competitive and democratic (Gibson 2012; Giraudy 2012).

\textit{Electoral Competition:} The primary independent variable is electoral competition. Electoral competition, in the long-run, should generate outcomes that reflect citizens’ interests.

\textsuperscript{14} But see Pope and Dockery 2013 for criticisms.
(Schattschneider 1949); however, faced with the risk of losing an election, parties may be willing to exchange private goods (relaxing environmental regulations and zoning restrictions, ignoring violations, etc.) in order to gain political support or needed campaign resources. Municipal governments are run by a popularly elected municipal council or ayuntamiento. Members of this council are elected for three year terms via open list proportional representation. Mayors (Municipal Presidents) are not independently elected but instead are chosen from the party that won the most votes in the last election. Mayors have not historically been able to seek reelection.\textsuperscript{15} The size of these council’s varies by population.

In order to take into account the contradictory influences that political competition may have on the provision of public goods, we use two indicators to ascertain whether electoral competition induces municipal officials to provide cleaner air to voters.\textsuperscript{16} First, we use the

\begin{footnotesize}
\textsuperscript{15} A recent constitutional amendment has changed this rule to allow for two consecutive terms in office. However, this was not in effect for the elections studied in this paper.

\textsuperscript{16} Both indicators are derived from official municipal election results. Most election results were downloaded directly from the Centro de Investigación para el Desarrollo Electoral data base: \url{http://cidac.org/base-de-datos-electoral/}. When necessary, election results were supplemented from data available from individual state election commissions. One of the main characteristics of municipal election is that the council president (the “mayor”) is elected directly through a plurality vote without a run-off. Council members are elected from a closed party list which is headed by each party's or coalitions candidate for council president. The rules for electing council members vary by state and by the size of the municipality. However, almost all large municipalities incorporate some form of proportional representation.
\end{footnotesize}
Effective Number of Parties\(^{17}\) in the previous election to measure the extent that a single party dominates the municipal city council and municipal elections. Lower partisan dominance within a city council should reduce the autonomy of politicians to use municipal resources for clientelistic exchanges (Bersch, Praça and Taylor 2017) and stimulate the provision of public goods. Even when a single party controls the city council, the presence of the opposition should significantly increase oversight and transparency. The Effective Number of Parties within a municipality also acts a good proxy for the political heterogeneity of voters, which increases the costs of using clientelism to secure votes and should increase the provision of public goods (Dixit and Londregan 1996; Kitscheit and Wilkinson 2007a).

Lizzeri and Persico (2005) argue that, as the number of political parties increases, electoral incentives push parties towards the provision of private goods and public goods provision is maximized with only two candidates. In political systems with a large number of effective political parties, this conclusion makes sense. However, giving the relatively low number of effective parties in Mexico’s municipal elections – 82% of election have fewer than three effective parties and the median value of Effective Number of Parties is 2.24 – it is not clear that the inefficiencies generated by the participation of more parties in municipal elections would outweigh the benefits generated by greater public debate and increased third-party monitoring of

\(^{17}\) For example, in the case of municipal elections, the Effective Number of Parties counts the number of parties that participated in the election and, at the same time, weights that number by the relative electoral strength of each party. When two parties equally split the vote 50%-50%, there are two parties, but if one part receives 70% of the votes and another 30%, the relative weakness of the second party causes the Effective Number of Parties to fall to 1.43.
government activities. Chhibber and Nooruddin (2004) set their threshold for two-party completion as any jurisdiction with less than three effective parties.

The Laakso-Taagepera index ($N_{LT}$) of the effective number of parties is one of the most widely used measures of the effective number of parties in an election (Laakso and Taagepera 1979). However, Golosov (2009) shows that the $N_{LT}$ can produce unrealistic values when a party receives significantly more than 50% of the vote. The $N_{LT}$ may also register high values in elections with many unimportant parties. As such, this paper measures the effective number of parties using the index proposed by Golosov (2009):

$$N_i = \sum^x_i 1/(1 + (s^2_i/s_i) - s_i),$$

where $s_i$ is the largest vote share.

The second measure of political competition is the Margin of Victory between the first and second place party (coalition) in the last election.\(^{18}\) The Margin of Victory provides an intuitive indicator of electoral competition since an election with a Margin of Victory of 1% or 2% is clearly more competitive than an election where the closest competitor lost by 10% or 20%. However, many doubt that a lower Margin of Victory will have a clear association with the provision of public goods. Pribble (2013) points out that incumbents may have large margins of victory because they successfully provide desired public goods. Highly competitive elections may also cause incumbents to choose to secure political support through clientelistic networks (Magaloni, Diaz-Cayeros, and Estevez 2007). Even in the face of narrow margins of victory, when a jurisdiction elects multiple representatives, the total number of votes needed for victory may diminish even though the voting margins remain the same. This may encourage politicians

\(^{18}\) Electoral competition variables are time lagged by at least one year; for example, for the 2014 panel, election results from the nearest election before 2014 were used.
to cater to the interests of specific constituents, rather than provide public goods (Lizzier and Persico 2005).

Although the Margin of Victory is a common indicator of electoral competition, in the case of city council elections, where multiple council members are elected from a single constituency, it can easily misrepresent the degree of competition. Imagine two municipalities. In the first, two parties split the vote 55% - 45%. In the second, three parties split the vote 41% - 30% - 29%. In the latter, the Margin of Victory is higher, but there is clearly more competition and we would expect the leading party to be more constrained in its action.

**Control Variables:** Several factors beyond the degree of electoral competition influence the supply and demand for environmental public goods as well as the amount of air pollution that we would expect to find in locality regardless of the degree of electoral competition. These factors include the socio-demographic composition of the community, the size of the municipality, the size and composition of the economy, and its principal geographic characteristics.

In our theoretical discussion, we argued that voters in richer communities (*GDP per capita*) tend to be more preoccupied with the provision of clean air, while those in poorer communities may favor political parties that provide jobs, public services, and subsidies over those that provide less tangible and less visible goods.\(^{19}\) There is also strong theoretical reason to believe that richer voters are less susceptible to vote buying, which encourages the provision of

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\(^{19}\) Citizens in richer communities also have more resources available to support non-governmental organization seeking clean air through the education of voters and lobbying of politicians.
public goods as a means of differentiating between candidates (Dixit and Londregan 1996; Kitscheit and Wilkinson 2007a; Hicken 2011).

Similarly, at the local level, it is likely that the amount of financial resources available to local governments plays an important role in the provision of clean air. Electoral competition provides incentives, but fiscal resources may allow local government to better implement and enforce environmental regulations. The provision of clean air requires personnel and infrastructure to monitor and regulate pollution as well as fiscal resources to implement projects to reduce contamination. Boulding and Brown (2014), using the size of budgets as a proxy for the resources available to incumbents, suggest that resources allow incumbents to increase voter mobilization through the provision of public goods, thereby reducing electoral competition and allowing the incumbent to win by big margins. As such, we examine whether municipal governments with more Municipal Resources, measured by net municipal revenue per capita, have lower levels of pollution.

Air pollution is directly linked to human activity, especially economic activity. For this reason, our models include several measures of economic and industrial activity at the municipal level. The level of overall economic activity is measured taking municipal GDP per km² (\(GDP\ Density\)).\(^{20}\) Since municipalities have different surface areas and our measure of air pollution is

the average PM2.5 density over the area of the municipality, we must take into account economic activity in reference to the surface area of the municipality.

Mexico’s environmental law reserves the regulation of numerous industries for federal authorities and, while municipal authorities are charged with monitoring all industries within their jurisdiction, they have little control over the operation and regulation of industries reserved for federal regulation: Chemicals and Paints, Petroleum and Petrochemicals, Cellulose and Paper, Metals, Glass, Cement and Asbestos, and Energy Production. The presence of these industries within a municipality may limit the ability of local officials to curtail PM2.5 emissions. We take into account the presence of these industries through the variable *Density of Federally Regulated Production*, which measures the average value of production of these industries per km². Interestingly, although some of the industries reserved for federal regulation produce very large volumes of PM2.5 particulates (e.g. energy production), in terms of their ratio of emissions to value of production, most federally regulated industries are relatively clean.²¹ We also take into account the presence of “dirty” industries within a municipality. The density of

production of the five “dirtiest” industries has been included as control variable: *Density of High Pollution Production*.\(^22\)

The physical character of municipalities directly influences air quality. Although we often associate rural communities with cleaner air; however, for any given level of economic activity, urban centers are often more efficient. Urbanization is also associated with greater heterogeneity among voters and other characteristics which increase the costs obtaining electoral support through clientelistic networks (Hicken 2007; Chandra 2007). We, therefore, control for the percent of municipal surface area covered by urban structures.\(^23\) The amount of surface area covered by forest not only provides an indicator of the presence of air cleaning vegetation, it is

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\(^{22}\) These industries were selected based on their volume of PM2.5 emissions divided by their total value of production. These industries include: other non-metal mineral products, wood, non-clothing textiles, leather production and products, and glass. Trash service is the most polluting industry by value; however, due to poor data at the municipal level in the published census data, trash services have not been included and have been replaced by glass. The selection of industries is based on data from Dirección General de Gestión de la Calidad del Aire y RETC (2013), Inventario Nacional de Emisiones de México 2008, Secretaría de Medio Ambiente y Recursos Naturales, Gobierno de México, México; Dirección General de Gestión de la Calidad del Aire y RETC (2012), Inventario Nacional de Emisiones de México 2005, Secretaría de Medio Ambiente y Recursos Naturales, Gobierno de México, México.

\(^{23}\) These indicators are based on data obtain via the “Descarga Masiva” page of the Instituto Nacional de Estadística y Geografía de México available at

[http://www3.inegi.org.mx/sistemas/descarga](http://www3.inegi.org.mx/sistemas/descarga); data was downloaded on December 12, 2015.
also a good proxy for the airidness of a region. Rain helps reduce the build-up of air pollution and keeps topsoil from being blown into the atmosphere.\textsuperscript{24} We also take into account the elevation of the municipality.

Additionally, we control for municipal populations. For many economists, larger municipalities should benefit from economies of scale when providing public goods (Boyne, 1995; Dangey and Hicks 2011). Although a municipality of 10,000 inhabitants should produce fewer contaminants than a municipality of 100,000 inhabitants, the latter may be more likely to have the administrative infrastructure necessary to properly monitor and regulate industries, motor vehicles, and other sources of air pollution. Larger populations also decrease the utility of clientelistic networks (Wang and Kurman 2007) and has been shown to shift municipalities towards meritocratic bureaucracies (Ruhil 2003). We may therefore expect municipalities with higher populations to have cleaner air \textit{ceteris paribus}. On the other hand, there is little empirical support for economies of scale in the provision of public goods for all but the smallest municipalities (Holzer 2009). Dollery and Fleming (2006) argue that for labor intensive public goods, like inspecting and monitoring sources of pollution, there is little reason to believe that municipalities may benefit from economies of scale.

\textsuperscript{24} Average days with rain would be very useful indicators of geological conditions, but they are not available at the municipal level.
Finally, we might expect better educated populations (rate of literacy) to be more concerned with environmental issues and air quality. Better educated individuals tend to have greater concern for the environment and objective pro-environmental behavior (Gifford and Nilsson 2014). Better educated citizens are also more likely to vote (Carreras and Castañeda-Angarita 2014) and tend to be less likely to be exposed to vote buying (Gonzalez Octantos et. al 2014), which makes them more likely to judge candidates and parties on their provision of public goods. We might also assume that better educated voters are less susceptible to vote buying and
prefer the provision of public goods from politicians. For these reasons, we control for municipal literacy rates. Summary statistics of all variables are presented in Table 1.

Although this study focuses on the provision of clean air at the municipal level, there is no reason to believe that the regulation of pollution evolves in the same way across Mexico’s different states. State governments have significant resources which they can use to influence pollution levels in their cities. Many states have designed their own environmental programs that interact with those of municipalities and the federal government. Differences in levels of electoral competition and which political parties dominate state-level politics as well as other socio-economic factors (e.g. cartel activity) may produce differences in the development and implementation of environmental regulation across states. For this reason, dummy variables have been included for Mexico’s states as well as an individual time trend for each state.\textsuperscript{25} The state-level time trend allows us to take into account the evolution of environmental politics within each state.

\textbf{Empirical Findings}

To evaluate the influence of political competition on air quality we estimate several spatial lag municipal random intercepts panel models. Each panel includes four time periods: 1999, 2004, 2009, and 2014. We selected these years because of the availability of industrial and economic data at the municipal level. The five year period between the time periods guarantees at least one individual trend lines were also estimated for each municipality. Within these models, the effective number of political parties retains its association with clean air, but all other variables lose their significance.

\textsuperscript{25}
municipal election in between. In other words, we use electoral competition measures based on the latest previous election outcome. This makes sense given the fact that efforts by politicians to decrease air pollution may require a significant amount of time to implement and take effect.

To take into account auto correlation across time all models are estimated with an autoregression correlation structure of order one (AR1). To take into account the influence of air pollution in neighboring municipalities, the average PM2.5 densities of adjacent municipalities during the previous year have been included as a spatial lag.

The empirical model can be expressed as follows:

\[ y_{it} = \delta W y_{it-1} + x_{it} \beta + \lambda t + q_s + \tau_s t + \zeta_i + \mu_{it}, \]

where the random intercept \((\zeta_i)\) is independently distributed \(\zeta_i \sim N(0, \omega^2)\). A general trend line \((\lambda t, \text{where } t \text{ takes on values between 1 and 4 because of 4 time periods})\) is also estimated to account for changes produced by federal regulations, technological inovation, etc. Each state has

\[ 26 \text{ Other correlation structures were also estimated with no significant change to the empirical results.} \]

\[ 27 \text{ To mitigate the simultaneity bias in the estimation of spatial lag models, the spatial lag is lagged by one year. The assumption here is that outcomes in location } i \text{ get influenced by outcomes in neighboring areas after a time lag. Lagging the spatial lag has become a common practice in some of the recent studies, mainly because it provides a simpler way to control for spatial dependence (by simple OLS regression) in relation to a spatial maximum likelihood approach (spatial ML) and spatial two-stage-least-squares instrumental variable approach (2SLS). However, this strategy of lagging the spatial lag terms is based on an assumption of the absence of instantaneous effect.} \]
an individual intercept \( \varphi_s \) and an individual time trend \((\tau_s t)\). The residuals \( u_{it} \) can be decomposed into two components: \( \phi u_{it-1} + \epsilon_{it} \), where \( \epsilon_{it} \) is independently distributed \( \epsilon_{it} \sim N(0, \sigma^2) \); this is the AR1 correlation structure. The model says that levels of PM2.5 in a municipality during a given year depends on the average levels of PM2.5 in neighboring municipalities during the previous year \((\delta W y_{it-1})\). In this formulation the spatial spillover does not depend on weather patterns and the geography of the region.

To facilitate the interpretation of the empirical results we estimate all associations between levels of PM2.5 and the explanatory variables as elasticities. This is normally done using a log-log model: taking the log of the dependent variable and of any explanatory variable not already expressed in percentages. However, for small value the logarithmic scale does not function well for elasticities and it is undefined for values of zero. Given that many of the control variables have small values and some have observations with a value of zero, the inverse hyperbolic sine (asinh) is used. The asinh allows us to use the same transformation for all variables while continuing to interpret the relationship between the variables as elasticities.

The Federal District is not included in this analysis because first, a lack of clear fiscal data for the district government would have meant excluding Municipal Resources as a control variable. Second, given that it is the country’s capital it would be impossible separate the influence of local political competition from pressure generated by members of the national government or issues of national prestige.

There is little doubt that urban politics is different from rural politics and that metropolitan regions have different economic and demographic characteristics. The fact that many of Mexico’s 55 metropolitan regions include state capitals also gives us good reason to expect a difference in how political competition influences the provision of public goods within
metropolitan and non-metropolitan municipalities. Many metropolitan regions also encompass more than one municipality, which may significantly change the political efficiency of pollution reduction for municipal leaders. To take into account these factors, all models are also estimated using only municipalities within Mexico’s metropolitan regions as well as using only non-metropolitan municipalities. Although the values of specific coefficient differ in these models, the positive association between political competition and cleaner air holds for both metropolitan and non-metropolitan municipalities. Given that our more general findings do not change in these models, the estimated results of the metropolitan and non-metropolitan models are not presented here and but are available upon request.

Table 2 presents the results of the estimated relationship between both the Margin of Victory and the Effective Number of Parties during the last election and PM2.5 levels within all municipalities. Because of the relatively high level of correlation between Margin of Victory and the Effective Number of Parties separate models are estimated for each. The first models take into account electoral completion include all the control variables with the exception of Density of Federally Regulated Production and Density of High Pollution Production. The next models include these two variables. The final models include the interaction between the measures of electoral competition and municipal GDP per capita. This allows us to evaluate whether authorities in low-income areas relax their monitoring and regulation of contaminants when facing greater political competition in order to attract industries and gain votes.
Table 2. Influence of Political Competition on Air Pollution (PM2.5)

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<th>(4)</th>
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<td>Margin of Victory (%)</td>
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<td>0.007</td>
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<tr>
<td>Effective Number of Parties</td>
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<td>Density of Economic Activity</td>
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<td>0.011***</td>
<td>0.012***</td>
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<tr>
<td>GDP per capita</td>
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<td>-0.013***</td>
<td>-0.013***</td>
<td>-0.014***</td>
<td>-0.013***</td>
<td>-0.018***</td>
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<tr>
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<tr>
<td>Literacy (%)</td>
<td>-0.001**</td>
<td>-0.001**</td>
<td>-0.001**</td>
<td>-0.001**</td>
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<td>(0.0005)</td>
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<tr>
<td>Population</td>
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<td>-0.001</td>
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<tr>
<td>Urban Area (%)</td>
<td>-0.059***</td>
<td>-0.058***</td>
<td>-0.058***</td>
<td>-0.056***</td>
<td>-0.058***</td>
<td>-0.058***</td>
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<td>(0.020)</td>
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<tr>
<td>Forested Surface Area (%)</td>
<td>-0.121***</td>
<td>-0.122***</td>
<td>-0.118***</td>
<td>-0.119***</td>
<td>-0.118***</td>
<td>-0.119***</td>
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<tr>
<td></td>
<td>(0.016)</td>
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<td>Elevation</td>
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</tr>
<tr>
<td>Density of High Pollution Production</td>
<td>-0.002**</td>
<td>-0.003**</td>
<td>-0.002**</td>
<td>-0.003**</td>
<td>-0.002**</td>
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<td>(0.001)</td>
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<tr>
<td>Density of Federally Regulated Industries</td>
<td>0.001</td>
<td>0.000</td>
<td>0.001</td>
<td>0.000</td>
<td>(0.001)</td>
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<tr>
<td>Margin of Victory × GDP per cap</td>
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<td></td>
<td></td>
<td></td>
<td>-0.001</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>(0.005)</td>
<td></td>
</tr>
<tr>
<td>Effective Number of Parties × GDP per cap</td>
<td></td>
<td></td>
<td></td>
<td>0.002</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>(0.001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spatial Lag_t-1</td>
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<td>0.921***</td>
<td>0.923***</td>
<td>0.922***</td>
<td>0.923***</td>
<td>0.922***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
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<tr>
<td>Constant</td>
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<td>0.263***</td>
<td>0.237***</td>
<td>0.249***</td>
<td>0.236***</td>
<td>0.259***</td>
</tr>
<tr>
<td></td>
<td>(0.076)</td>
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<td>(0.076)</td>
<td>(0.076)</td>
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<tr>
<td>Groups (municipals)</td>
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<td>1,887</td>
<td>1,887</td>
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<td>1,887</td>
<td>1,887</td>
</tr>
<tr>
<td>Observations</td>
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<td>6,965</td>
<td>6,965</td>
<td>6,965</td>
<td>6,965</td>
<td>6,965</td>
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<tr>
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<td>5,445</td>
<td>5,433</td>
<td>5,436</td>
<td>5,429</td>
<td>5,431</td>
</tr>
<tr>
<td>Akaike Inf. Crit.</td>
<td>-10,744</td>
<td>-10,748</td>
<td>-10,722</td>
<td>-10,726</td>
<td>-10,711</td>
<td>-10,715</td>
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<tr>
<td>Bayesian Inf. Crit.</td>
<td>-10,259</td>
<td>-10,263</td>
<td>-10,222</td>
<td>-10,227</td>
<td>-10,205</td>
<td>-10,209</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parentheses (* p < 0.05, ** p < 0.01, *** p < 0.001). Coefficients for state dummy variables, the general trend line, and state trend lines included in the model estimations but not reported here because of space limit. Estimated using a random intercepts model and AR1 auto-correlation in R version 3.3.2 using the lme() command in the nlme package.
The results presented in Table 2 suggest that smaller margins of victory do not induce politicians to provide cleaner air. Across all models, Margin of Victory lacks a statistically significant association with PM2.5 levels. This is not surprising given that incumbents may win election by a wide margin of victory by providing public goods, while closer margins of victory may induce politicians use available resources to shore-up support through targeted spending. Larreguy, Marshall, and Trucco (2015) find that programmatic policies can increase support for municipal incumbents. On the other hand, Durazo Herrmann (2012) provides the example of Ulises Ruis who was elected in one of Oaxaca’s most competitive elections and immediately used targeted spending to reinforce his legitimacy among voters. It is also thought that Ruis siphoned resources from other projects to fund his clientelistic network.

As expected, the Effective Number of Parties is positively associated with cleaner air across all models. Greater political heterogeneity raises the costs of pursuing electoral support through clientelistic relations; greater heterogeneity on the city council should improve oversight and limit accesses to needed patronage resources. On average, 1% increase of in the Effective Number of Parties variable is associated with at least a decrease of 0.005% in average PM2.5 levels across the whole surface area of the municipality. The estimated substantive effect may seem inconsequential. However, it needs to be remembered that PM2.5 levels are the average levels across the entire surface area of the municipality. As such, we can assume that the decrease at points of production are actually much higher. If most of the emissions occur in urbanized areas, which represent only a fraction of most municipalities (80% of municipalities have urbanization levels below 3%), a small average decrease in PM2.5 across the whole surface area of the municipality requires a much more significant decrease within urban areas.
Results from Table 2 suggest that municipalities with a richer population (GDP per capita) tend to have cleaner air. We suspect that this is because richer communities tend to demand better standards of living and a cleaner environment. Richer populations may also look unfavourably on sacrificing environmental quality in order to attract or retain industries. Poor communities, on the other hand, may willingly give up clean air for jobs and industry. This suggests that voters’ preferences (at least when proxied by per capita GDP) influence environmental outcomes. These findings also fit with the argument that it is costlier to maintain clientelistic relations with richer voters.

No evidence exists for an interaction between GDP per capita and levels of political competition. The lack of an interaction suggests that political competition does not significantly influence the sensitivity of politicians to the environmental policy preference of voters. This result should not necessarily be taken to mean that politicians facing greater political completion do not seek to secure the support of poorer voters through clientelistic networks. Rather, the trade-offs between the provision of clean air and patronage may be more complex than the provision of public services like socio-spending and education and patronage based politics. While it is easy to imagine politicians quickly shifting funds from one program to another or using funds from a programmatic policy to provide jobs to supporters, regulating and monitoring pollution depends more on bureaucratic capacity and political will than fiscal resources. This makes policies oriented towards clean air more difficult to cannibalize for clientelistic purposes. Once implemented, regulations may be politically sticky. Enterprises that paid the cost of adjustment or benefited from reduced competition may object to reducing standards or monitoring once they have already paid the costs reducing emissions.
Political competition is not the only factor that influences environmental outcomes. Economic, demographic, and geographic factors all contribute to PM2.5 levels. Control variables included in Table 2 test the effects of these variables. As expected, higher literacy rates are negatively associated with air pollution. For obvious reasons, municipalities with more forests tend to have cleaner air.

Given the costs involved with monitoring industries, regulating vehicle emissions, implementing policies to mitigate pollution and clean the air, we expected that municipalities with greater per-capita resources would have cleaner air. Interestingly the coefficient for \textit{Municipal Resources} is statistically insignificant across all models. This result may stem from the ability of politicians to garner political support through the provision of more visible public services. Although richer municipalities may have more resources available to clean-up the air, they may also have lower incentives to pursue difficult measures to reduce pollution, since they can garner support through the provision of more visible public goods. As such, the financial resources dedicated to the provision of clean air may be fairly inelastic. Since many of the policies required for cleaner air depend more on political will and regulatory capacity fiscal resources may have swiftly declining marginal returns.

Although we might expect that municipalities with larger populations to benefit from economies of scale and weaker clientelistic ties, we find no such evidence. This fits with the argument that labor intensive public goods, like regulating and monitoring pollution sources, do not benefit from economies of scale (Dollery and Fleming 2006). The estimated results suggest that more urbanized municipalities (\% \textit{Urban}) have lower PM2.5 levels. This may seem contradictory, since we associate urban areas with higher industrialization and higher energy consumption. However, the models already take into account two major sources of energy
consumption and pollution: *Density of Economic Activity* and per capita GDP. As such, the negative association between urbanization and PM2.5 levels may capture the greater efficiency and cleanliness of urban areas (e.g. electricity and natural gas rather kerosene and wood, and buses instead of individual cars). At the same time, the increased heterogeneity of urban voters and their increased mobility, makes securing votes through clientelistic networks more difficult and incentivizes the provision.

A higher density of economic activity has a clear upward association with PM2.5 levels. Unexpectedly, the presence of high polluting industries has a slight negative relationship with PM2.5 levels. While these “dirty” industries produce relatively higher volumes of PM2.5 than other industries, government agencies may more strictly regulate and monitor their emissions. As such, other industries may actually contaminate relatively more because they can get away with not fully complying with federal, state, and local regulations.

**Conclusion and Discussion**

This paper studies whether political competition influences the air quality of local jurisdictions, using the case of Mexican municipalities. Instead of simply assuming a positive connection between electoral competition and environmental public goods provisions, we argue that the relationship might also be a function of public preferences between environmental and economic public goods. Employing a spatial analysis of air quality across time and across Mexico’s

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28The estimated substantive relationship between the density of economic activity and PM2.5 levels is highly elastic. An increase of 1% in economic activity is associated with an increase in PM2.5 levels of approximately 0.01%.
municipalities, we find a negative association between electoral competition and political heterogeneity measured by the *Effective Number of Parties* in the previous election and PM2.5 air pollution. We suspect that greater political heterogeneity within a municipality improves monitoring of incumbents and incentives the provision of public goods. Improved monitoring and greater political heterogeneity should also limit the ability of politicians to use municipal resources to support clientelistic networks. As such, an increase in the *Effective Number of Parties* may improve the quality and experience of officials responsible for monitoring and enforcing emissions regulation and for implementing pollution reduction policies.

We find that local environmental demands (proxied by GDP per-capita) have a positive association with cleaner air. This fits well with the literature on vote buying and clientelism, which expects richer voters prefer programmatic policies over transfers of public goods and may punish clientelistic administrations (Dixit and Londregran 1996; Magaloni, et. al 2007). It is most likely that richer voters are both more concerned with the overall quality of government (Weitz-Shapiro 2014) and begin to give the environment higher priority as they become better-off (Grossman and Krueger 1995).

Contrary to expectation, we find no interaction effect between GDP per-capita and electoral competition. This null finding may stem from the fact that at low levels of political competition politicians are insulated from the environmental / developmental interests of voters’ political demands and their socio-economic conditions may only influence political strategies when competition is high (Magaloni, el at 2007; Weitz-Shapiro 2014). Most studies of the influence of political competition, clientelism, and the provision of goods to voters in Lain America focus on distributive politics, spending, and intra-structure (Kitschelt and Wilkinson 2007b; Stokes et al 2013; Weitz-Shapiro 2013; Brun and Diamond 2014), rather than pure(er)
public goods like air pollution. The lack of an interaction may also stem from the type of public good being provided. Although monitoring and regulated emissions requires fiscal resources, the clear costs to some voters, especially small enterprises, and the diffuse benefits providing clean air, may make political will and an independent bureaucracy more important than access to fiscal resources. The trade-off for politicians is not between deciding whether to use highly fungible fiscal resources to provide private or programmatic services, but whether demands for environmental public goods out weight the political costs of restricting and lowering emissions.

The results of this paper have proved contrary to the work of Cleary (2007) and others who find no association between political competition and the provision of public services by Mexican municipalities. These results have been interpreted as evidence that political competition does not induce politicians to provide public goods. Rather, Cleary (2007) argues that the provision of public services is positively associated with political participation. One important difference between our findings and the findings of previous work is that public services are not pure public goods. Because the provision of public services depends on the fiscal resources of the municipal government, their provision may be significantly influenced by the diversion of fiscal resources into projects and programs that benefit political supporters, when

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29 We re-estimate the models used by Cleary 2007: Table 3, replacing the dependent variable – Sewer Coverage – with PM2.5 levels. We find no relationship between the change in pollution levels and the measure of political competition used by Cleary 2007: ten-year average margin of victory. However, when we replace ten-year average margin of victory with the ten-year average number of effective parties, greater political competition has a positive association with cleaner air. At the same time, political participation is not associated with air pollution.
incumbents face significant political competition. Air quality, on the other hand, is much more non-rival and non-excludable.

Future research should better study the effects of political participation. Cleary (2007) argues that the provision of public services is positively associated with political participation rather than electoral competition. We can follow Cleary (2007) and use data on electoral turnout to test whether our results on electoral competition still hold: note that Cleary (2007) use literacy and poverty rates as additional measures for political participation; we have included literacy rate in our analysis and found that it has a negative association with PM air pollution and environmental complaints. Finally, the relationship between electoral competition and public goods provisions might vary between types of public goods as a function of visibility and complexity. To fully test this argument requires, we need to select different public goods which vary on visibility and complexity.
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